Chapter 3

ANSWERS

Multiple Choice Questions

1. (d)

(ii) 20 moles of water = 20 ×18 g = 360 g of water, because mass of 1 mole of water is the same as its molar mass, i.e., 18 g.

(iv) 1.2044×10^{25} molecules of water contains

$\frac{1.2044\times10^{25}}{N_A}$ number of moles, $N_A = 6.023\times10^{23}$

$\therefore \frac{1.2044\times10^{25}}{6.022\times10^{23}} = 20$ moles

20 moles of water = 20×18 g

= 360 g of water.

2. (a) Inert gases exist in monoatomic form.

3. (b)

4. (d)

5. (c)

Weight of a sample in gram = number of moles × molar mass

(a) 0.2 moles of $C_{12}H_{22}O_{11}$ = 0.2 × 342 = 68.4 g

(b) 2 moles of CO_2 = 2×44 = 88 g

(c) 2 moles of $CaCO_3$ = 2×100 = 200 g

(d) 10 moles of H_2O = 10×18 = 180 g

6. (d)

$$\text{Number of atoms} = \frac{\text{Mass of substance} \times \text{Number of atoms in the molecule}}{\text{Molar mass}} \times N_A$$

$\therefore$ (a) 18 g of water = $\frac{18\times3}{18}\times N_A = 3\,N_A$

(b) 18 g of oxygen = $\frac{18\times2}{32}\times N_A = 1.12\,N_A$

(c) 18 g of CO_2 = $\frac{18\times3}{44}\times N_A = 1.23\,N_A$

(d) 18 g of CH_4 = $\frac{18\times5}{16}\times N_A = 5.63\,N_A$

7. (c)

1 g of $H_2 = \frac{1}{2} \times N_A = 0.5 N_A$

$= 0.5 \times 6.022 \times 10^{23}$

$= 3.011 \times 10^{23}$

8. (a)

Mass of one atom of oxygen = Atomic mass/N_A

$= \frac{16}{6.022 \times 10^{23}}$ g

9. (a)

Number of moles of sucrose $= \frac{\text{Mass of substance}}{\text{Molar mass}}$

$= \frac{3.42\ \text{g}}{342\ \text{g mol}^{-1}} = 0.01\ \text{mol}$

1 mol of sucrose ($C_{12}H_{22}O_{11}$) contains $= 11 \times N_A$ atoms of oxygen

0.01 mol of sucrose ($C_{12}H_{22}O_{11}$) contains $= 0.01 \times 11 \times N_A$ atoms of oxygen

$= 0.11 \times N_A$ atoms of oxygen

Number of moles of water $= \frac{18\ \text{g}}{18\ \text{g mol}^{-1}} = 1\ \text{mol}$

1 mol of water (H_2O) contains $1 \times N_A$ atom of oxygen

Total number of oxygen atoms = Number of oxygen atoms from sucrose + Number of oxygen atoms from water

$= 0.11\ N_A + 1.0\ N_A = 1.11 N_A$

Number of oxygen atoms in solution = 1.11 × Avogadro's number

$= 1.11 \times 6.022 \times 10^{23}$

$= 6.68 \times 10^{23}$

10. (c)

Short Answer Questions

11. (b) $BiPO_4$ — Both ions are trivalent

Bismuth phosphate

12. (a) $CuBr_2$

(b) $Al(NO_3)_3$

(c) $Ca_3(PO_4)_2$

(d) Fe_2S_3

(e) $HgCl_2$

(f) $Mg(CH_3COO)_2$

13. $CuCl_2$/ $CuSO_4$/ $Cu_3(PO_4)_2$
NaCl/ Na_2SO_4/ Na_3PO_4
$FeCl_3$/ $Fe_2(SO_4)_3$/ $FePO_4$

14.

Anions	Cations
(a) CH_3COO^-	Na^+
(b) Cl^-	Na^+
(c) It is a covalent compound	
(d) NO_3^-	NH_4^+

15. (a) CaF_2 (e) Na_2O
(b) H_2S (f) CO, CO_2
(c) NH_3
(d) CCl_4

16. (a) Incorrect, the correct symbol of cobalt is Co
(b) Incorrect, the correct symbol of carbon is C
(c) Incorrect, the correct symbol of aluminium is Al
(d) Correct (He)
(e) Incorrect, the correct symbol of sodium is Na

17.

(a) NH_3	(b) CO	(c) HCl	(d) AlF_3	(e) Mg S
N : H × 3	C : O	H : Cl	Al : F × 3	Mg : S
14 : 1 × 3	12 : 16	1 : 35.5	27 : 19 × 3	24 : 32
14 : 3	3 : 4	2 : 71	9 : 19	3 : 4

18. (a) 4 (b) 5
(c) 7 (d) 2

19. ~ 8/18
Mass of one mole (Avogadro Number) of neutrons ~ 1 g

Mass of one neutron = $\frac{1}{\text{Avogadro Number } (N_A)}$ g

Mass of one molecule of water = $\frac{\text{Molar mass}}{N_A} = \frac{18}{N_A}$ g

There are 8 neutrons in one atom of oxygen

Mass of 8 neutrons = $\frac{8}{N_A}$

Fraction of mass of water due to neutrons ~ $\frac{8}{18}$

20. Yes, it is a temperature dependent property. The solubility generally, increases with increase in temperature. For example, you can dissolve more sugar in hot water than in cold water.

21. (a) 2 (b) 3 (c) 3 (d) 8 (e) 4 (f) 4 (g) 14 (h) 3 (i) 2 (j) 5

(k) 1 (Noble gases do not combine and exist as monoatomic gases)

(l) Polyatomic. It is difficult to talk about the atomicity of metals as any measurable quantity will contain millions of atoms bound by metallic bond (about which you would learn later).

22. On heating the powder, it will char if it is a sugar.

Alternatively, the powder may be dissolved in water and checked for its conduction of electricity. If it conducts, it is a salt.

23. Number of moles $= \frac{12}{24} = 0.5$ mol

Long Answer Questions

24. (a) CO_2 has molar mass $= 44 g\ mol^{-1}$

5 moles of CO_2 have molar mass $= 44 \times 5$

$= 220$ g

H_2O has molar mass $= 18\ g\ mol^{-1}$

5 moles of H_2O have mass $= 18 \times 5$ g

$= 90$ g

(b) Number of moles in 240g Ca metal $= \frac{240}{40} = 6$

Number of moles in 240g of Mg metal $= \frac{240}{24} = 10$

Ratio 6:10

3: 5

25. (a) $CaCO_3$

Ca : C:O × 3

40 : 12 : 16×3

40 : 12 : 48

10 : 3: 12

(b) $MgCl_2$

Mg : Cl × 2

24 : 35.5 × 2

24 : 71

(c) H_2SO_4

H × 2 : S : O × 4

1 × 2 : 32 : 16 × 4

2 : 32 : 64

1 : 16 : 32

(d) C_2H_5OH

C × 2 : H × 6: O

12 × 2 : 1 × 6: 16

24 : 6 : 16

12 : 3 : 8

(e) NH_3

N : H × 3

14: 1 × 3

14:3

(f) $Ca(OH)_2$

Ca : O × 2 : H × 2

40 : 16 ×2 : 1 × 2

40 : 32 : 2

20 : 16 : 1

26. 1 mole of calcium chloride = 111g

$\therefore$ 222g of $CaCl_2$ is equivalent to 2 moles of $CaCl_2$

Since 1 formula unit $CaCl_2$ gives 3 ions, therefore, 1 mol of $CaCl_2$ will give 3 moles of ions

2 moles of $CaCl_2$ would give 3×2=6 moles of ions.

No. of ions = No. of moles of ions × Avogadro number

$= 6 \times 6.022 \times 10^{23}$

$= 36.132 \times 10^{23}$

$= 3.6\ 132 \times 10^{24}$ ions

27. A sodium atom and ion, differ by one electron. For 100 moles each of sodium atoms and ions there would be a difference of 100 moles of electrons.

Mass of 100 moles of electrons = 5.48002 g

Mass of 1 mole of electron $= \frac{5.48002}{100}$ g

Mass of one electron $= \frac{5.48002}{100 \times 6.022 \times 10^{23}} = 9.1 \times 10^{-28}$g

$= 9.1 \times 10^{-31}$ kg

28. Molar mass of HgS = 200.6 + 32 = 232.6 g mol^{-1}

Mass of Hg in 232.6 g of HgS = 200.6 g

Mass of Hg in 225 g of HgS $= \frac{200.6}{232.6} \times 225 = 194.04$g

29. One mole of screws weigh = 2.475×10^{24}g $= 2.475 \times 10^{21}$ kg

$$\frac{\text{Mass of the Earth}}{\text{Mass of 1 mole of screws}} = \frac{5.98 \times 10^{24}\,\text{kg}}{2.475 \times 10^{21}\,\text{kg}} = 2.4 \times 10^{3}$$

Mass of earth is 2.4×10^3 times the mass of screws

The earth is 2400 times heavier than one mole of screws.

30. 1 mole of oxygen atoms = 6.023×10^{23} atoms

$\therefore$ Number of moles of oxygen atoms $= \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$

$= 4.28$ mol

4.28 moles of oxygen atoms.

31. (a) Mass of sodium atoms carried by Krish = (5 × 23) g = 115 g

While mass of carbon atom carried by Raunak = (5 ×12) g = 60g

Thus, Krish's container is heavy

(b) Both the bags have same number of atoms as they have same number of moles of atoms

32.

Species	H_2O	CO_2	Na atom	$MgCl_2$
Property				
No. of moles	2	0.5	5	0.5
No of particles	1.2044×10^{24}	3.011×10^{23}	3.011×10^{24}	3.011×10^{23}
Mass	36g	22g	115g	47.5g

33. Number of moles of stars = $\frac{10^{22}}{6.023 \times 10^{23}}$

= 0.0166 mols

34. (a) kilo (b) deci (c) centi (d) micro (e) nano (f) pico

35. (a) 5.84×10^{-9} kg
(b) 5.834×10^{-2} kg
(c) 5.84×10^{-4} kg
(d) 5.873×10^{-24} kg

36. A Mg^{2+} ion and Mg atom differ by two electrons.
10^3 moles of Mg^{2+} and Mg atoms would differ by
$10^3 \times 2$ moles of electrons
Mass of 2×10^3 moles of electrons = $2 \times 10^3 \times 6.023 \times 10^{23} \times 9.1 \times 10^{-31}$ kg
$\Rightarrow$ $2 \times 6.022 \times 9.1 \times 10^{-5}$kg
$\Rightarrow$ 109.6004×10^{-5} kg
$\Rightarrow$ 1.096×10^{-3}kg

37. (i) 100 g of N_2 = $\frac{100}{28}$ moles

Number of molecules = $\frac{100}{28} \times 6.022 \times 10^{23}$

Number of atoms = $\frac{2 \times 100}{28} \times 6.022 \times 10^{23} = 43.01 \times 10^{23}$

(ii) 100 g of NH_3 = $\frac{100}{17}$ moles = $\frac{100}{17} \times 6.022 \times 10^{23}$ molecules

$= \frac{100}{17} \times 6.022 \times 10^{23} \times 4$ atoms

$= 141.69 \times 10^{23}$

NH_3 would have more atoms

38. 5.85 g of NaCl = $\frac{5.85}{58.5} = 0.1 \text{ moles}$

or 0.1 moles of NaCl particle

Each NaCl particle is equivalent to one Na^+ one Cl^-

$\Rightarrow$ 2 ions

$$\text{Total moles of ions} = 0.1 \times 2$$

$$0.2 \text{ moles}$$

No. of ions= $0.2 \times 6.022 \times 10^{23}$

$\Rightarrow 1.2042 \times 10^{23}$ ions

39. One gram of gold sample will contain $\frac{90}{100} = 0.9$ g of gold

$$\text{Number of moles of gold} = \frac{\text{Mass of gold}}{\text{Atomic mass of gold}}$$

$$= \frac{0.9}{197} = 0.0046$$

One mole of gold contains N_A atoms = 6.022×10^{23}

$\therefore$ 0.0046 mole of gold will contain = $0.0046 \times 6.022 \times 10^{23}$

= 2.77×10^{21}

40. Atoms of different elements join together in definite proportions to form molecules of compounds. Examples— water, ammonia, carbondioxide. Compounds composed of metals and non-metals contain charged species. The charged species are known as ions. An ion is a charged particle and can be negatively or positively charged. A negatively charged ion is called an anion and the positively charged ion is called cation. Examples— sodium chloride, calcium oxide.

41. Mass of 1 mole of aluminium atom = the molar mass of aluminium

= 27 g mol^{-1}

An aluminium atom needs to lose three electrons to become an ion, Al^{3+}

For one mole of $A1^{3+}$ ion, three moles of electrons are to be lost.

The mass of three moles of electrons = $3 \times (9.1 \times 10^{-28}) \times 6.022 \times 10^{23}$ g

= $27.3 \times 6.022 \times 10^{-5}$ g

= 164.400×10^{-5} g

= 0.00164 g

Molar mass of Al^{3+} = (27–0.00164) g mol^{-1}

= 26.9984 g mol^{-1}

Difference = 27 – 26.9984

= 0.0016 g

42. Mass of silver = m g

Mass of gold $= \frac{m}{100}$ g

Number of atoms of silver = $\frac{\text{Mass}}{\text{Atomic mass}} \times N_A$

$= \frac{m}{108} \times N_A$

Number of atoms of gold $= \frac{m}{100 \times 197} \times N_A$

Ratio of number of atoms of gold to silver = Au : Ag

$= \frac{m}{100 \times 197} \times N_A : \frac{m}{108} \times N_A$

= 108 : 100×197

= 108 : 19700

= 1 : 182.41

43. Mass of 1 molecule of $CH_4 = \frac{16\,g}{N_A}$

Mass of 1.5×10^{20} molecules of methane $= \frac{1.5 \times 10^{20} \times 16}{N_A}$ g

Mass of 1 molecule of $C_2H_6 = \frac{30}{N_A}$ g

Mass of molecules of C_2H_6 is $= \frac{1.5 \times 10^{20} \times 16}{N_A}$ g

$\therefore$ Number of molecules of ethane $= \frac{1.5 \times 10^{20} \times 16}{N_A} \times \frac{N_A}{30} = 0.8 \times 10^{20}$

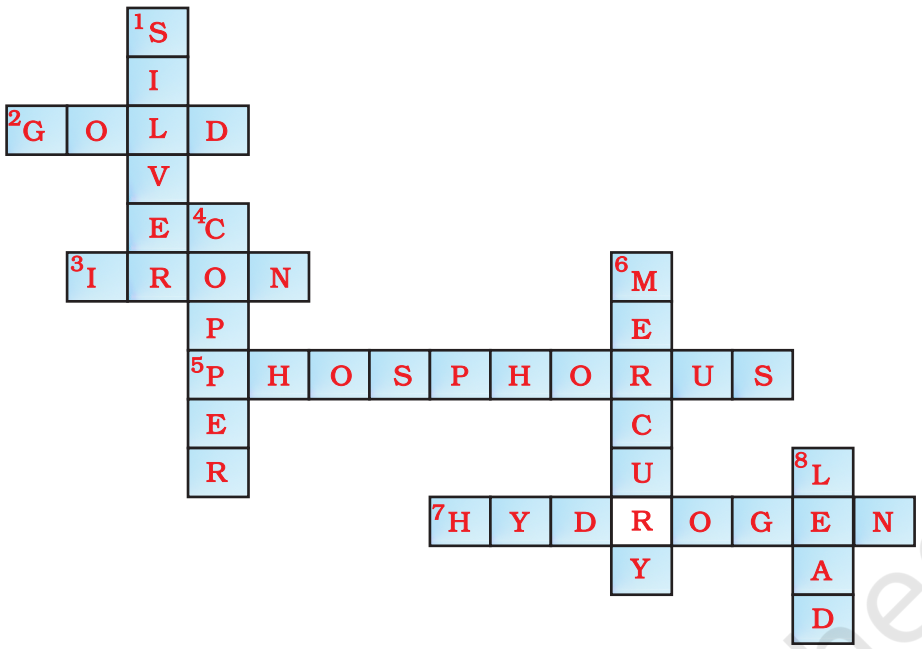
44. (a) Law of conservation of mass

(b) Polyatomic ion

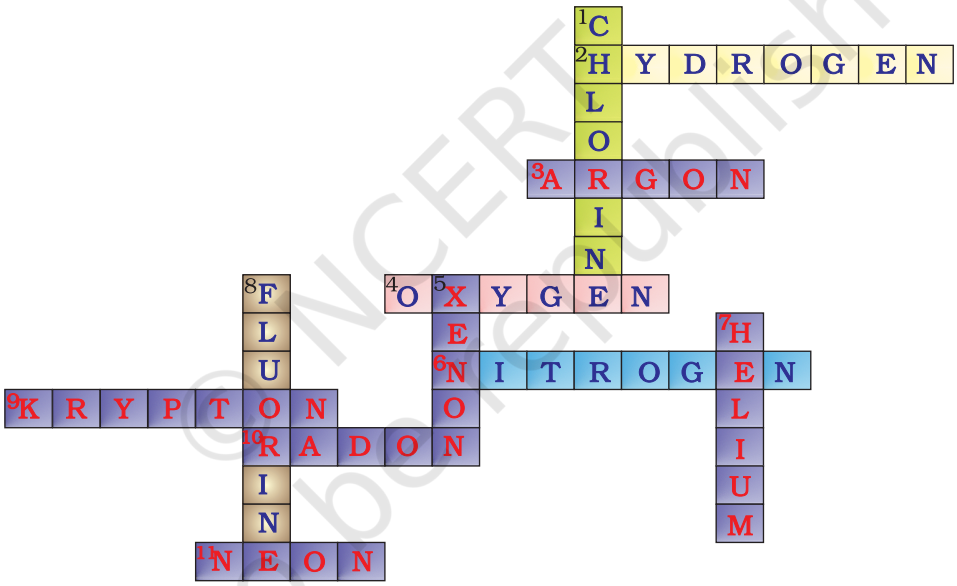
(c) (3 × atomic mass of Ca) + (2 × atomic mass of phosphorus) + (8 × atomic mass of oxygen) = 310

(d) Na_2CO_3; $(NH_4)_2SO_4$

45.



46 (a)



(b) Six : Helium (He); Neon (Ne); Argon (Ar); Krypton (Kr); Xenon (Xe); Radon (Rn).

47. (a) KOH

$(39 + 16 + 1) = 56 \text{ g mol}^{-1}$

(b) $NaHCO_3$

$23 + 1 + 12 + (3 \times 16) = 84 \text{ g mol}^{-1}$

(c) $CaCO_3$

$40 + 12 + (3 \times 16) = 100 \text{ g mol}^{-1}$

(d) NaOH

$23+16+1 = 40 \text{ g mol}^{-1}$

(e) $C_2H_5OH = C_2H_6O$

$2 \times 12 + (6 \times 1) + 16 = 46 \text{ g mol}^{-1}$

(f) NaCl

$23 + 35.5 = 58.5 \text{ g mol}^{-1}$

48. $6CO_2 + 6H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$

1 mole of glucose needs 6 moles of water

180 g of glucose needs (6×18) g of water

1 g of glucose will need $\frac{108}{180}$ g of water.

18 g of glucose would need $\frac{108}{180} \times 18$ g of water = 10.8 g

Volume of water used $= \frac{\text{Mass}}{\text{Density}} = \frac{10.8 \text{ g}}{1 \text{g cm}^{-3}} = 10.8 \text{ cm}^3$.